



INSTITUTE FOR DEFENSE ANALYSES

Can Profit Policy and Contract Incentives Improve Defense Contract Outcomes?

Scot A. Arnold, Project Leader
David L. McNicol
Kenton G. Fasana

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PREFACE

The Institute for Defense Analyses (IDA) prepared this report for the Deputy Under Secretary of Defense (Profit Policy) under a task titled “Profit Policy Research.” This paper assesses the effectiveness of government contracting incentives on defense firm behavior during the acquisition process.

Stanley A. Horowitz, Michael S. Nash, and James P. Woolsey of IDA were the technical reviewers for this paper.

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SUMMARY

The Under Secretary of Defense for Acquisition, Technology, and Logistics in 2007 issued guidance entitled “Strategic Goals and Implementation Plan.” Goal 5 (Reliable and Cost-Effective Industrial Capabilities Sufficient to Meet Strategic Objectives) directed that “contract finance and profit policies drive desired results.” This language apparently was intended to direct the vigorous use of the tools provided by contract finance and profit policies to substantially improve the outcomes of acquisition contracts, in particular, the delivery on time and within budget of systems that provide the capabilities for which the Department of Defense contracted.¹

Using the profit and contract finance policies to motivate contractors requires a clear understanding of these tools and their features. Moreover, it is necessary to know not only what tools are available but how effective each is and how they might interact. With this in mind, the Office of the Deputy Under Secretary of Defense for Industrial Policy asked IDA to explore the incentive effects of DoD policies on profit and contract finance: How do changes in profit policy induce changes in contractor behavior? Can profit policy incentivize cost, schedule, and performance results? How strong are these incentive effects relative to the many other factors that affect contract outcomes?

The IDA study was concerned mainly with the acquisition of weapon systems (rather than services or commodities), especially major defense acquisition programs. The study took place within the framework of the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS), the principal body of regulations governing DoD acquisitions. The goal of the study was to understand the incentive features provided in the FAR and DFARS—what they are, how they work, and how effective they are. We did not consider how the tool set could be improved by changes to the DFARS or to the DoD acquisition system more generally.

¹ “Profit policy” is a term used in the Defense Department that commonly covers the weighted guidelines set forth in DFARS 215.404–70 through 215.404–76. We broadened the definition to include contract type selection, incentive, and award fees. All of these influence the profit earned by defense contractors. Some other factors that also affect profit—e.g., accounting rules that govern allowable costs—are not ordinarily considered part of profit policy.

The DFARS contains:

- *Provisions* (commonly referred to as “weighted guidelines”) on the determination of the base fee specified in a typical DoD acquisition contract and
- *Guidelines* on choice of contract type, including, in particular, contracts with incentive features.

We also considered the incentive effects that operate across the sequence of contracts, from development through full-rate production, through which acquisition programs typically proceed.

The specific conclusions we reached are as follows:

1. The facilities markup was used successfully in the mid-1970s to increase the capital/labor ratios of defense contractors. Such use of facilities markup would influence cost, not cost growth. The effect on cost depends on the capital/labor ratio. If the amount of capital employed already is at the optimal level, further increases (induced by increases in the facilities markup) will increase, not reduce, cost. Accordingly, facilities markup is not a tool that is easy to use.
2. The elements of weighted guidelines can usefully be thought of as being like prices; but by increasing certain prices the government can induce firms to propose more technically challenging approaches, put greater effort into management of contract outcomes, and be more willing to undertake the risks associated with a fixed-price contract. We do not know the magnitude of these effects, however, and they may be masked by other factors. Consequently, this linkage cannot be systematically exploited to promote better contract outcomes.
3. This study, like several past studies, finds that contracts with incentive fee or award fee provisions generally have less cost growth than contracts without such provisions. This finding does not imply, however, that greater use of these contracts by the Defense Department would produce better contract outcomes. This is true for several reasons. The most important is that the Defense Department cannot simply force contractors to take on the greater risk of a contract with incentive features. Contracts are negotiated, and the degree of risk is not just a matter of provisions on fee; target cost also matters, and a contractor presumably would seek to offset the risk introduced by negotiating a higher target cost. The net result could be a contract that experiences less cost growth but with a cost to the Defense Department that is the same or even greater. It is also important to realize that the observed reduction in cost growth may be inextricably linked to the selection bias created by matching lower risk projects to contracts that transfer successively more risk to the contractor.
4. The comparatively large profits during the production phase of an acquisition have an important incentive effect. A defense firm ordinarily must first win a development contract to be chosen eventually to produce the system. Firms win competitions by developing the system that the Defense Department judges to

be the best. In that way, the lure of profit during the production phase incentivizes the behavior during development and low-rate initial production that the Department seeks.

5. There is a tension between the goals of the incentive provisions of development and low-rate production contracts and the cross-contract incentives of comparatively large profits of the production phase. On the one hand, the prospect of large profits during the production phase can be expected to reduce the effectiveness of incentives in development and early production contracts intended to lower procurement cost, and therefore lower profit during production. On the other hand, a vigorous and effective use of incentive features of profit policy during development and early production would, then, run the risk of greatly attenuating the cross-contract incentive feature of profit policy.

Taken as a whole, these conclusions tend to suggest that there is not a realistic prospect of using the incentive tools permitted by DFARS to greatly improve the average performance, schedule, and cost outcomes the Defense Department obtains.

I. INTRODUCTION

The Under Secretary of Defense for Acquisition, Technology, and Logistics in 2007 issued guidance entitled “Strategic Goals and Implementation Plan.” Goal 5 (Reliable and Cost-Effective Industrial Capabilities Sufficient to Meet Strategic Objectives) directed that “contract finance and profit policies drive desired results.” This language apparently was intended to direct the vigorous use of the tools provided by contract finance and profit policies to substantially improve the outcomes of acquisition contracts, in particular, the delivery on time and within budget of systems that provide the capabilities for which the Department of Defense contracted.¹

Using the profit and contract finance policies to motivate contractors requires a clear understanding of these tools and their features. Moreover, it is necessary to know not only what tools are available but how effective each is and how they might interact. With this in mind, the Office of the Deputy Under Secretary of Defense for Industrial Policy asked IDA to explore the incentive effects of DoD policies on profit and contract finance: How do changes in profit policy induce changes in contractor behavior? Can profit policy incentivize cost, schedule, and performance results? How strong are these incentive effects relative to the many other factors that affect contract outcomes?

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The DFARS contains:

- *Provisions* (commonly referred to as “weighted guidelines”) on the determination of the base fee specified in a typical DoD acquisition contract and
- *Guidelines* on choice of contract type, including, in particular, contracts with incentive features.

The incentive features of these two sets of provisions are examined in Chapters II and III. The discussion in each of these chapters focuses on the consequences of incentive features of a particular contract for the outcome of that contract. Chapter IV looks at incentive effects that operate across the sequence of contracts, from development through full-rate production, through which acquisition programs typically proceed.

These comments might suggest that the paper will culminate in identification of the features of profit policy that are particularly effective in incentivizing desirable contract outcomes and perhaps some suggestions on how those features can be better employed. In fact, the conclusions offered in Chapter V are of a different character. We did find features of profit policy that “work” as incentives, so their effects are visible in data we examined. These effects are not dominant, however, and provide no reason to believe that (in the words of Goal 5) profit policy can “drive desired results.” Probably more important, we note a way in which vigorous and effective use of incentives while a system is in development to limit unit cost may well have adverse effects on the performance of the system developed.

The main body of the paper does not discuss contract financing provisions because our examination did not reveal ways in which contract financing provisions could plausibly be used to incentivize particular outcomes. The appendix, however, reports our examination of whether the overall returns to defense contractors are adequate to retain in the defense industry the capital they have committed. In that context, we briefly note the relationship between progress payment rates and the profits of defense contractors.

II. DO CHANGES IN PROFIT GUIDELINES SYSTEMATICALLY INFLUENCE CONTRACT OUTCOMES?

This chapter examines whether the profit guidelines in the DFARS systematically influence the prevalence of cost growth, schedule slips, and performance shortfalls on individual contracts. Profit guidelines are also often called the “weighted” guidelines for a reason that will subsequently become apparent.

A. DFARS PROFIT GUIDELINES

Table 1 displays the profit policy guidelines as currently described in DFARS for cost-plus-fixed-fee (CPFF) and firm-fixed-price (FFP) contracts.² Under a CPFF contract, the government pays all contractor costs and a fixed fee upon completion. A CPFF contract is typically used for research and development (R&D) projects where there is considerable uncertainty in the effort that will be required. Since the government agrees to pay all costs, a CPFF contract places minimal risk on the defense firm. A CPFF contract will include a target cost. The fee ordinarily is stated as a percentage of that cost. The fee is fixed in the sense that it depends on the target cost, not the cost actually incurred.

Four main factors go into the construction of the fee: performance risk (which has two components, technical and management/cost control); contract risk; cost efficiency; and facilities capital. The DFARS provides guidelines for each of these. The construction of the fee proposed by the government essentially is a matter of the contracting officer applying these guidelines to the facts of a particular contract.

The contracting officer would first determine an appropriate value of fee for technical risk and for management risk and the weight to be assigned to each of these. Working from the top of Table 1 down, suppose, for example, that a CPFF contract requires taking a key subsystem from a Technology Readiness Level (TRL) 4 (development) to TRL 6 (demonstration). The contracting officer might judge the risk of

² The weighted guidelines address all contract types. For illustrative purposes, we look in this section at the guidelines only for CPFF and FFP contracts.

Table 1. DFARS Profit Guidelines for Cost-Plus-Fixed-Fee and Firm-Fixed-Price Contracts

	Cost-Plus-Fixed-Fee Contract			Firm-Fixed-Price Contract			Guidelines—Should Reflect:
	Low ^a	Mid ^b	High ^c	Low ^a	Mid ^b	High ^c	
Performance Risk ^d							
Technical ^{e, f}	3.0	5.0	7.0	3.0	5.0	7.0	The effort required to manage the expected technical uncertainties
Management/Cost Control ^e	3.0	5.0	7.0	2.0	3.0	4.0	The effort to meet contract requirements at or below desired cost
Contract Type Risk ^{d, g}	0.0	0.5	1.0	0.0		4.0	The degree of cost risk accepted by the contractor—depends on contract type, financing, length, escalation clauses, nature and degree of subcontracts, and ceilings
Cost Efficiency ^d	0.0		4.0	0.0		4.0	The demonstrated efforts by contractors to reduce cost: prior contract achievements; reduction or elimination of idle facilities; investments in efficient facilities, etc.
Working Capital (Adjustment for FFP Contract Type)	Not applicable			Formula based on contract length, the amount of working capital funded by contractor, and appropriate government interest rate			The cost of using the contractor's capital to fund working capital. This fee is only available to fixed price contracts with progress payment financing
Facilities Capital ^h	10.0	17.5	25.0	10.0	17.5	25.0	The cost of investing in equipment required to execute the contract; should capture the usefulness of the equipment to the DoD

Note: The weighted guidelines can be found in DFARS section 215.404–71.

^a Below-normal conditions would apply to contracts where: the program is mature, is a follow-on, or has simple requirement ; the contractor adds minimal value; routine efforts and little supervision are required; prior efforts to control costs have been below standard; old or idle facilities are being used; or equipment being produced has little benefit to the DoD.

^b The midpoint represents the normal conditions and most contracts should fall under this fee guidance.

^c Above-normal conditions would apply to contracts where: manufactured items have stringent tolerances; skilled personnel or state-of-the-art equipment is required; a high degree of development/production concurrency is required; a breakthrough technology needed; the contractor has accepted higher risk through accelerated schedules, committing internal R&D funding, or additional warranty provisions; the contractor has a good track record of cost estimating, tracking, and control; large scale integration is required; investment is being made in R&D equipment; the equipment being produced has direct or measurable benefits in efficiency or cost.

^d Fee terms are in percentage of contract cost (material, labor, and overhead).

^e The technical and management fees are multiplied by weighting factors that can range between 0 and 1, where both factors add to one. The weights should reflect the relative importance and effort associated with the technical and management risks.

^f For some types of efforts, contracting officers authorized to promote the incorporation of innovative technologies can add up to 4 percentage points to the range and midpoint of the technical risk fee only.

^g The fixed-price contract values shown are for a contract with progress payments. If the contractor uses performance payments, the contracting officer would add 1 percentage point to the midpoint and range. If the contract includes no financing (i.e., the contractor must fund working capital with private funds), the contracting officer would add 2 percentage points to the midpoint and range.

^h Fee terms are a percentage of the accounting value of the assets employed by the contract.

this to be “high” and assign the maximum value of 7 percent to technical risk. He then might determine that management/cost control risk is above average and assign a value of 6 percent for it. The total performance risk is calculated as a weighted average of technical risk and management/cost control risk. If we assume the contracting officer selects weights of 50 percent for each, the total performance risk is, then, 6.5 percent ($[0.5 \times 7\%] + [0.5 \times 6\%]$).

The next factors in calculating fee are contract risk and cost efficiency. Contract risk is always comparatively low for a CPFF contract—at most 1 percent. Suppose that in the case at hand the contracting officer believes the risk to be about average for CPFF contracts and allows a value of 0.5 percent for contract risk. The contracting officer can also allow a cost efficiency adjustment if the firm has demonstrated some sort of cost efficiency. In this particular case, assume that the contractor has a good record of containing costs and has also presented a plan to perform value engineering throughout the execution of the contract. On this basis, the contracting officer might allow, say, 1 percent in fee because of cost efficiency.

The fee arrived at so far in this example is 8 percent (6.5 percent performance risk, 0.5 contract risk, and 1 percent cost efficiency). This 8 percent is applied to the sum of the total cost of materials, labor, and overhead.

The final element in fee for a CPFF contract is payment for facilities capital, which is intended to reimburse the firm for equipment capital costs associated with the contract. The rate at which facilities capital is reimbursed has a range of 10 percent to 25 percent with a midpoint of 17.5 percent. As with the other elements of the weighted guidelines, the contracting officer would apply the relevant DFARS guideline to select the percentage used in computing the fee for facilities capital. If the contracting officer determines that the acquisition project requires more capital than normal, he might specify a facilities capital value greater than 17.5 percent, but not greater than the 25 percent upper limit. If less capital than normal is required, then the weight might be set below 17.5, but not below 10 percent. Note that the facilities capital markup is applied to capital expenses employed in the execution of the contract.³ Also note that this reimbursement will be paid to the company incrementally during the term of the contract.

³ The government reimburses only the capital costs of equipment. Capital costs of land and buildings are not reimbursed. For example, if equipment capital costs associated with a defense contract are \$100 million and the facilities markup is 17.5 percent, then the reimbursement to the company would be \$17.5 million.

Table 1 also displays the profit guidelines for Firm-Fixed-Price (FFP) contracts. These differ from the guidelines for CPFF contracts in only two respects. First, where the contract risk for CPFF contracts ranges from 0 to 1 percent, the range for FFP contracts is 2 percent to 4 percent. Second, the fee for a FFP contract contains a component for working capital.

The profit (or fee) specified in a DoD contract is not specified unilaterally by the government in accordance with the profit guidelines. It is subject to negotiation between the Defense Department and the contractor. The guidelines are used by the contracting officer to form the Department's offer. The guidelines also are an important part of the framework of the negotiation and generally act to limit the fee that the government will pay in various circumstances.

B. PERFORMANCE AND CONTRACT RISK

The discussion now turns to the question of whether changes in the amounts allowed for performance risk, contract risk, and cost efficiency can be expected to have a systematic connection to contract outcomes—in particular, to cost growth, schedule slips, and performance shortfalls. The reason for considering facilities capital separately will be revealed shortly.

Performance shortfalls, schedule slips, and cost growth require management attention, which is costly, and may also increase costs in other ways. They also can tarnish a firm's reputation, putting future business at risk. These factors are reasons for a firm to be concerned with providing the capability the Defense Department seeks on schedule and within the target cost.

The question here is whether changes in the profit guidelines make these incentives stronger. Looking at the execution of a contract once it is signed, we might arrive at the apparent answer that they do not. The reason is simply that, in contrast to the incentive contracts discussed in the following section, what the firm gets paid is fixed when the contract is signed, not by what happens subsequently. That is, there is no link between fee and actions the firm takes to avoid adverse outcomes or to the outcomes themselves. Since there is no link between the profit guidelines and the firm's actions, there is no reason to think that they would be affected by changes in profit guidelines. This is equally true for both CPFF and FFP contracts.

There is, however, another pathway that must be considered. This one works through the proposals that firms make and the content of the contracts negotiated. The

question is: Will changes in the profit guidelines for performance and contract risk predictably lead to differences in what is placed on contract? In particular, would increases in the maximum fees allowed for technical, managerial/cost control, and contract risk predictably lead firms to propose more technically challenging, and presumably more innovative and risky, approaches; propose more intense efforts to manage cost, schedule, and performance; and be more ready to accept an FFP contract?

Firms operating under the norms of U.S. business would seek the higher returns to the extent it is reasonable in the light of the following:

- A more technically challenging approach generally is subject to greater risk of performance shortfalls, schedule slips, and cost overruns.
- Performance shortfalls, schedule slips, and cost overruns impose some costs on the firm, as noted previously.
- Increased managerial effort to better manage performance, schedule, and cost also will often come at higher cost.
- A firm ordinarily will accept the greater risk of an FFP contract only if it has a commensurate prospect of greater reward.

The underlying point here is simply that in a commercial setting, a customer generally can obtain “more” of something by offering to pay more. Thus, we expect that increases in returns for technical, managerial/cost control, and contract risk would lead to more risky contracts and greater efforts to manage cost, schedule, and performance.

We have no basis for saying how large this effect may be for two reasons. First, there is little or no information available about the underlying considerations, e.g., the cost and effectiveness of increased managerial effort. Second, even if substantial, the effect might be masked by other factors, in particular, by competition.

Unfortunately, there does not seem to be a viable approach to estimating how large the effect would be of increasing the top end of the fee ranges for performance and contract risk. The magnitudes of the top of the ranges for technical, managerial/cost, and contract risk have changed little over the past 25+ years.⁴ Consequently, there is virtually no prospect that an historical approach would be fruitful. The other straightforward alternative would be to construct a model to be used as an experimental test bed. Not enough information about the underlying factors is known, however, for the results of such an exercise to carry any weight.

⁴ See the previous IDA study by Arnold, Harmon, Tyson, Fasana, and Wait (2008).

We do have strong expectations about the direction of the effects. In particular, we expect a reduction in the top of the fee range for technical risk, an increase for managerial/cost, and an increase for contract risk for FFP would tend to reduce cost growth.

C. COST EFFICIENCY

A contracting officer can offer up to 4 percent in fee on a contract under negotiation for past steps by the contractor to reduce costs. The main points made in the previous section about performance risk and contract risk also apply to cost efficiency:

The amount included in fee for contract risk does not provide the firm executing a contract with any greater incentives to provide the deliverables specified in the contract on schedule and within the target cost.

The government can “buy” more cost reduction efforts from firms that expect to remain as defense contractors by increasing payments for “cost efficiency.”

We have no basis for gauging how large this effect might be. In addition, the effectiveness of offering an increment to fee for “cost efficiency” depends on the government’s ability to measure cost reduction efforts and effects, and on the contractors’ perceptions that their efforts on cost reduction will be recognized in the context of future contract awards and that fees for “cost efficiency” will still be paid then.

D. FACILITIES MARKUP

The facilities markup was added to the weighted guidelines in the mid-1970s to encourage defense firms to employ more capital in the acquisition process. Studies during the mid-1970s concluded that the defense industry was not employing sufficient capital. The Profit '76 study of 1976, in particular, found that the defense industrial base had less than half the capital intensity as peer capital goods manufacturers in the United States.⁵ The Defense Financial and Investment Review of 1984 also reached this conclusion.⁶ The facilities capital markup was introduced to motivate contractors to substitute more capital for labor.

⁵ See Assistant Secretary of Defense (Installations and Logistics) (1976).

⁶ See Defense Manpower Data Center (1984).

The simple intuition behind this innovation was that paying an additional amount linked to facilities capital lowers the cost of capital equipment to the firm over the duration of the contract. Since the cost of labor remains unaffected, the firm has an incentive to substitute capital and the value of the capital (K) employed will increase vis-à-vis labor (L). Conversely, if the payment linked to facilities capital is reduced, the firm would then have an incentive to substitute the relatively cheaper labor for capital (decreasing the K/L ratio).⁷

Empirical evidence for the most part supports the theory that the facilities capital midpoint and the defense industry K/L ratio are positively correlated. From 1976 to 1986, the DFARS midpoint for facilities increased three times (to 8 percent, 18 percent, and 30 percent). Each increase in the facilities markup was followed by a corresponding increase in defense industry K/L ratio. From 1987 through 2006, the results are less conclusive. Defense industry capital and labor data are not readily available. As a result, a proxy ratio of capital expense divided by depreciation was used for the top defense primes. In 2002, this ratio fell after a significant reduction in the facilities capital midpoint (from 30 percent to 17.5 percent) as the theory predicts; however, the years preceding and subsequent to 2002 seem unpredictably volatile. This volatility may be due to many exogenous factors. Two of the most probable are (1) the post-cold war decline in defense procurement put negative pressure on capital spending; and (2) defense industry consolidations during the 1990s left surviving firms with excess capital capacity. These two concurrent factors may be responsible for fluctuations in K/L over the last 15 years.

Finally, evidence from the military aircraft industry shows that increases in the defense industry K/L ratio may lower cost. During the period 1977 to 1987 the facilities capital markup experienced a fourfold increase. As expected, the military aircraft industry K/L ratio nearly doubled from the 1970s to the 1990s. IDA also found a significant downward effect on aircraft unit labor costs during this same period. This analysis linking increases in K/L to decreases in cost applies only to the military aircraft manufacturers; however, this segment represents a significant portion of the defense industry, suggesting that the K/L-to-cost relationship may have wider applicability.

⁷ Note that this scenario assumes all other factors remain constant. In reality, there are a host of other internal and external factors that can influence the cost of capital and labor.

E. CONCLUSIONS

The question asked in this chapter is whether the DFARS profit guidelines systematically influence the prevalence of cost growth, schedule slips, and performance shortfalls on individual contracts. The answer offered is a heavily qualified “yes.”

Changes in fee for performance risk, contract risk, and cost efficiency do not directly influence firms’ management of performance, schedule, and cost.

These elements of profit guidelines can usefully be thought of as being like prices; by increasing them, the government can induce firms to propose more technically challenging approaches, put greater effort into management of contract outcomes, and be more willing to undertake the risks associated with a fixed-price contract. We do not know the magnitude of these effects, however, and they may be masked by other factors. Consequently, this linkage cannot be systematically exploited to promote better contract outcomes.

An increase in the facilities markup was used successfully in the mid-1970s to increase the capital/labor ratios of defense contractors. Today, such a change in the facilities markup would influence cost, not cost growth. The effect on cost depends on the capital/labor ratio. If the amount of capital employed already is at the optimal level, further increases (induced by increases in the facilities markup) will increase, not reduce, cost. Accordingly, the facilities markup is not a tool that is easy to use.

III. CAN PROFIT POLICY EFFECTIVELY IMPROVE COST, SCHEDULE, AND PERFORMANCE RESULTS?

Part 16 of the FAR (Types of Contracts) describes the various incentive mechanisms permitted and provides guidelines on the circumstances in which the various contract types should be used. This chapter examines data that provide an indication of how effective these incentive mechanisms are in influencing outcomes on DoD acquisition contracts.

A. CONTRACT TYPES, INCENTIVE STRUCTURES, AND AWARD FEES

This section outlines the key distinctions between the main types of contracts that can be used in negotiated acquisitions.⁸ The focus is on how the different contract types motivate contractors to control costs. Contracts can be broken into two general types: cost-reimbursable contracts and fixed-price contracts. Each type includes a firm (i.e., fixed) base fee and may include an incentive or award fee. An incentive is usually tied to an objective measure of the contractor's performance, such as contract cost, while an award is granted to the contractor through subjective evaluations by the fee determination official.

The general principle behind FAR Part 15 contracting is to reimburse the contractor's allowable costs and to provide a reasonable profit. In a world without uncertainty, all contracts would be fixed price. However, uncertainty is common in defense contracting, and the degree of uncertainty around the estimated cost to complete the contracted project is the main criterion for selecting contract type. The logic behind contract type selection regulations is to start with a fixed-price contract and iteratively justify using a contract type that successively transfers more contract risk to the government until the level of uncertainty matches the contract type.⁹

Consider a project to develop a new missile. A highly accurate cost estimate, performance requirement, and schedule would be needed to apply the firm-fixed-price

⁸ As defined in the FAR, Part 15—Contracting by Negotiation.

⁹ The term “contract risk” is as defined in the weighted guidelines (see Table 1).

(FFP) contract type to this program. The FFP contract would provide the contractor with a firm price for delivering the missile design with clear requirements and a timeline for when the work was to be completed. The contract ceiling would be set to no more than the price of the contract. This ceiling exposes the contractor to a financial loss if the negotiated price is ultimately insufficient to execute the contract.

An FFP contract would not be appropriate in this case since the contractor could not reasonably absorb all of the uncertainties associated with a development program, or would, in the best case, demand a high price for doing so. The FFP contract is more appropriate for production programs where the contractor has gained enough experience to reasonably assume that it will earn its target profit rate.¹⁰ FFP contracts are used, for example, for full rate single-year or multi-year production purchases of aircraft.

The fixed-price incentive (firm target) (FPIF) contract type is ideal for a project dominated with production elements but with enough uncertainty around the level of effort that some cost sharing between the government and contractor is justified.

The elements of an FPIF contract are: a target cost and profit; a price ceiling that is used to define the obligation; and a profit adjustment formula that is coupled to the contract cost, either schedule or a performance metric (e.g., system weight), or both. A profit adjustment formula is composed of the profit target and terms that adjust the target according to the difference between the actual-at-completion and target incentive metrics. For example, when the incentive metric is contract cost, the factor is called the “cost share ratio.” The factor can be further divided into separate share ratios for target underruns and overruns.

When the contract is completed, the government and contractor negotiate the final allowed cost and other metrics and the final price is established by applying the profit adjustment formula. The price ceiling is the maximum price the contractor can receive except for adjustments under other contract clauses.¹¹ A final cost more than the target will result in a profit lower than target or even a loss; while a final cost less than the target will result in a profit higher than target. A cost incentive is required with schedule

¹⁰ We cover target profit rates in the next chapter, where we discuss the weighted guidelines.

¹¹ Most incentive contracts allow target relief against mitigating conditions such as contract uncertainties that are under control of the government or from which the government has indemnified the contractor.

or performance incentives. Multiple incentives would likely compete for net influence on the final profit.

FPIF contracts are used less frequently than FFP contracts; but they are common for low-rate initial production and for ships. These are both production environments where the manufacturing processes are not fully standardized. However, our example, a completely new missile development program, calls for a cost-reimbursable contract, where the government can absorb the cost impact of the effort uncertainty.

The cost-reimbursable equivalent of an FPIF contract is the cost-plus-incentive-fee (CPIF) contract. The CPIF contract has the same elements as the FPIF except that the contract ceiling should contain enough budget provision to manage the uncertainties implied by the task and keep the contractor from being contractually exposed to negative profits.¹² Again, the basic criterion is whether there is enough certainty with the program requirements to accurately estimate a contract target cost.

If, however, the missile program held too much uncertainty around the effort required, it would be unreasonable to expect the contractor to agree to a CPIF contract with such downside risk. In this case, a cost-plus-fixed-fee (CPFF) contract would be appropriate. The CPFF contract provides the contractor with a fixed fee in addition to full reimbursement of its allowed costs.¹³ The FAR guidelines recommend using a CPFF contract for projects where the level of effort required to complete the task is unknown. The contractor's fee is fixed at the onset of the contract, and its costs will be reimbursed (including a proration of the fee) periodically throughout the contract's execution.

In our descent from the high to low contract risk extremes in going from the FFP to the CPFF contract, respectively, we brushed over the complexity around implementing incentive contracts. The FFP and CPFF contract types at the contract risk extremes have the fewest elements that must be negotiated: the cost and price of the contract. Incentive contracts have at least four negotiated elements that can each contribute significantly to the final profit: the incentive metric targets (e.g., cost), the target profit,¹⁴ the incentive formula for each metric, and the actual metric value at contract completion.

¹² The contractor could apply its own internal research and development funding to ensure successful contract execution.

¹³ Allowable costs include most items; they exclude items like first-class travel and alcohol. A rough rule is to assume that allowed costs account for 99 percent of all contractor costs.

¹⁴ There is a maximum and possibly a minimum profit. The weighted guidelines apply to the target and provide a 0.5 percentage point increase in the contract risk target over CPFF contracts.

Compounding the complexity of managing so many separate parts in an incentive contract is that these elements are subject to negotiation throughout the contract's life as the government makes changes or other unforeseen events unfold. The typical incentive contract will not hold the contractor responsible for all increases in cost, schedule, or performance degradation. Target adjustments will ultimately require both parties to negotiate agreement on the estimates of what the new target should be. The effect of contract adjustments propagates through to contract completion where both parties must then negotiate agreement on the final metrics relative to their targets.¹⁵

In addition to the higher government effort to manage an incentive contract, target profits have been and remain at a premium to the average CPFF contract target profit.¹⁶ This reflects the fact that a contractor cannot be expected to accept added risk on a sustained basis on projects that ultimately do not at least pay for its cost of capital.

Finally, we mention the award fee contract. This structure is similar to incentive contracts in that it links profit to the contractor's performance. However, they differ in several ways. First, the award criteria are not necessarily linked to a performance formula; in most cases, the criteria are subjective. Second, their target profits are not covered by the weighted guidelines and hence could potentially provide both contract parties greater latitude. Third, the contractor's performance is evaluated and the award is granted at several intervals throughout the execution of the contract. And fourth, award fee budget not granted to the contractor in early evaluation periods can be awarded in later periods. This last difference is called "rollover," and it has been a key element of recent criticism from the Government Accountability Office (GAO) about the way the Defense Department manages award fee contracts.

The Department has issued guidance that it prefers acquisition programs first attempt to develop a suitable incentive fee contract. If the contracting office is not able to construct a reasonable profit adjustment formula, the award fee structure may be adopted. The Department's guidance also specifically recommends a percentage of maximum fee

¹⁵ Even after contract completion, negotiation may still go on. We are aware of a recent FPIF contract where the contractor successfully sued the government after final settlement for "equitable readjustment." In this case, the contractor successfully argued that the final cost performance was due to government changes outside the original scope of the contract.

¹⁶ We sampled about 6,900 Air Force and Army contracts, and measured negotiated profit premiums of 1.1 and 2.4 percentage points for CPIF and FPIF, respectively, over CPFF contracts. We do not know if these profit premiums were maintained *ex post*. Note that these premiums are higher than the mid-points in the weighted guidelines.

versus performance rating schedule. For example, contractors who perform satisfactorily can receive up to 50 percent of the maximum award.¹⁷

Cost-plus-award-fee (CPAF) contracts have become common for development programs and service acquisitions. Contractors have indicated a preference for CPAF over CPFF contracts because of the higher profit potential. They maintain that the greater profit potential enables them to attract higher caliber talent to the project with an award fee contract.

In this section, we described the key criterion for matching a project to the proper contract type: the contract risk as it manifests in the target cost estimate accuracy. If the accuracy of the project's cost estimate is low, the project is best matched with the contract types with less intrinsic contract risk. Following the guidelines correctly should result in less cost growth. For example, if the Defense Department were able to persuade a contractor to accept an FPIF contract for a project with a high level of uncertainty we would expect significant cost growth. Even if the contractor were to absorb the growth by suffering a financial loss, it is unlikely the contractor would repeat the mistake on the contract for any follow-on acquisitions. If the CPIF or CPFF structures had been chosen instead, we would expect lower cost growth.

In the next section we review several studies that look at the effect of contract type on cost growth. We also return to the notion that some of the findings about incentive contracts having lower cost growth can be explained by contracting officers having selected the right contract type for the acquisitions studied.

B. KEY FINDINGS OF PREVIOUS STUDIES

Incentive contracts were introduced into defense acquisitions over 50 years ago because DoD leadership believed they should lower costs. In practice, however, it is nearly impossible to show directly with empirical analyses whether incentive contracts lead to lower costs. Too many factors ultimately determine the final cost. Only cost growth is readily observable and comparable across contract types. Researchers have looked at settled contracts to see if incentive contract outcomes, especially cost growth, are consistent with the way the contracts are constructed and thereby infer whether these structures are more efficient. The analyses we reviewed looked at cost growth versus

¹⁷ See Assad (2007).

share ratio to determine whether a higher ratio led to lower cost growth as many versions of incentive theory suggest it would.

We reviewed several early but thorough studies of incentive contracts. All of the studies agree that incentive contracts reduce cost growth. Table 2 lists these studies, along with their primary results. (See the list of references for bibliographic information on these studies.) The earliest studies, by IDA (Cross) and RAND (Fischer), actually estimated the average percentage cost growth savings of incentive contracts relative to CPFF contracts. IDA estimated the difference between the target and final actual cost for the average incentive contract to be 6.3 percentage points lower than that for the average CPFF.¹⁸ RAND estimated the relative cost growth reduction to be 5.1 percent for FPIF versus CPFF and 0.6 percent for CPIF versus CPFF. With RAND's data, the average FPIF contract under-ran its target cost, while CPIF contracts had positive but lower cost growth than CPFF contracts.

Table 2. Empirical Studies of Incentive Contracts

Study	Year	Contract Data Used	Key Results
IDA (Cross)	1966	93 CPFF/ 43 FPIF contracts	Incentives yielded lower cost growth (6.3%) that more than offset their higher average fee rate (2.8%; net savings 3.5%); however, cost growth reduction was not related to share ratio
RAND (Fischer)	1968	1,007 Air Force contracts	Incentives yielded lower cost growth (FPIF vs. CPFF: 5.1%) that more than offset their higher average fee rate (3%; net savings 2.1%); however, cost growth reduction was not related to share ratio
U.S. Army (Launer)	1974	53 CPIF contracts (1964–71)	Share ratio drove under-runs but not overruns.
GAO	1987	62 FPIF contracts (1976–81)	The final contract costs were normally distributed around the target cost (average cost growth of 0.2%); however, cost growth reduction was not related to share ratio
IDA (Frazier, Cloos, and Kimko)	2001	7 CPIF/19 FPIF contracts (1992–99)	Lower cost growth was related to higher share ratio; average cost growth for the sample was –6%.

¹⁸ The average incentive contract experienced a cost under-run, while the average CPFF experienced an overrun. The study did not distinguish between incentive contract types.

The GAO study looked only at FPIF contracts and found that 53.2 percent of the contract sample overran costs, 43.5 percent under-ran costs, and the remainder hit the target cost. The average cost growth of the entire sample was 0.2 percent, and roughly half of the contracts' final cost fell within ± 5 percent of the target. The GAO explained these results in the same way IDA and RAND had 20 years before: the target price was set reasonably to minimize the likelihood of a cost overrun.

IDA and RAND did not find the expected relationship between cost growth and cost share ratio while GAO and a later IDA Study (Frazier, Cloos, and Kimko) found the expected relationship. The implication of these findings is that the incentive contracts do result in less cost growth, but the share ratio amplification effect is less certain. IDA, RAND, and to some degree the GAO attributed their findings of lower cost growth to informational asymmetry through which contractors bid higher targets to decrease the probability of exceeding them. IDA's later findings, however, indicate an increasing share ratio corresponds with lower cost growth, possibly reflecting an evolution in incentive contract implementation.

Another explanation for these findings that is not explicitly offered by the studies in Table 2 follows from the selection bias introduced through the contract type selection screen presented in the previous section. The FAR criterion used for selecting the contract type is to match projects with lower uncertainty with contract types that inherently expose the contractor to higher contract risk. What these studies may have observed was that this selection process, by itself, ultimately helped reduce cost growth on certain contracts. The implication here is that it is not necessarily the incentive effect that reduces cost growth or drives the contractor towards higher efficiency; rather, it is matching the right level of contract requirements accuracy to the appropriate level of contract risk. The contractor then negotiates a price sufficient to yield satisfactory profit.

C. SOME ADDITIONAL EVIDENCE

We looked at cost growth by contract using two different sets of data: (1) a subset of the earned-value (EV) data available in the Defense Acquisition Management Information Retrieval System and (2) initial and final costs in the Contractor Cost Data Reporting (CCDR) system. With both sets of data, we included only completed programs. The EV database yielded a sample of 294 contracts, From the CCDR reports, we were able to extract a sample of 200 completed contracts for major defense acquisition programs.

The contract type breakdown of our EV sample is shown in Table 3. Earned value reporting is uncommon for production programs; however, FFP contracts were used for development in the 1970s, 1980s, and 1990s. We used the cost performance index (CPI) to measure cost growth. CPI is defined as the *budgeted* cost divided by the actual cost of work performed. A CPI less than one shows actual costs larger than budgeted costs. While the CPI measure does not necessarily capture the same effect as the studies in Table 2, where the authors looked at final negotiated versus contract target costs, it does provide one indication of the magnitude of cost growth.

Table 3. Earned Value Data Sample Characteristics

	CPFF	CPIF	CPAF	FPIF	FFP	Unknown
Sample Breakdown by Contract Type	31	83	56	5	72	47
Cost Performance Index	0.97	0.94	0.96	0.93	0.88	0.93
Percentage Experiencing Budget "Re-baseline"	77%	69%	68%	64%	80%	45%

With CPI, the budget can be adjusted (called "re-baselined" in EV jargon) to add target relief for overruns caused by government changes as well as by contractor cost increases. Initially we looked only at contracts that were not re-baselined and found that contract type could not explain the variation in CPI among the sample with any statistical significance. When we included re-baselined contracts, we were still unable to find a significant relationship between contract type and cost growth.

Before we concluded that incentives had no effect on the cost growth within our sample of development contracts, we looked at how frequently each contract type received a new baseline (Table 3). There is a lower propensity for incentive and award contracts to have their budgets "re-baselined."¹⁹ CPFF and FFP contracts were more likely to have budget adjustments than were incentive and award fee contracts.²⁰ While cost growth benefits due to contract type appear absent in CPI, we believe that the adjustments to the data hide the benefit incentive contracts provide programs that have substantial cost growth, i.e., the ones that ultimately get re-baselined.

¹⁹ We could not quantify the benefits of this effect since the cost history was lost in the budget adjustment.

²⁰ The seemingly anomalous behavior of the FFP contracts in our EV sample is likely to be due to the wrong choice of contract type and that the contractor had no choice but to seek additional budget. Most of the FFP development contracts in our sample were in the 1980s; by the 1990s there were only a fifth as many FFP development contracts, and there are none in the 2000s.

Our analysis of the CCDR-base data is summarized in Table 4. The sample contract completion date period spans from 1969 through 2007. The cost growth index is the ratio of the final to initial cost. Aside from the CPFF index, cost growth appears to decline as more cost-risk is transferred to the contractor.²¹ Note also that for the incentive fee and FFP contracts as the contract cost-risk increases, the variance of the cost growth index decreases.

Table 4. CCDR Base Cost Growth Index by Contract Type

Contract Type	Average Final/Initial WBS Cost	Std. Deviation Final/Initial WBS Cost	Number of Contracts
CPFF	1.04	0.10	8
CPAF	1.87	0.85	4
CPIF	1.89	1.98	29
FPIF	1.16	0.39	26
FFP	1.23	0.78	69
FFP ^a	1.08	0.20	66

^a Three anomalous FFP contracts were removed from F-18 fighter, F-14D fighter, and F119 engine production sequences. These contracts had 400-600% cost growth.

Figure 1 shows the distribution of the cost growth index for the CPIF subset of contracts in the sample. The peak is at 1.0; however, the distribution is severely right-skewed.²² Figure 2 shows the distribution of the index for the FPIF sub-set of the sample. Again the peak is at 1.0; however, the distribution is not only tighter but it is symmetric (skew is 1.0).

For comparison, we calculated the cost growth index for the GAO study and plotted its distribution in Figure 2—both data sets are from FPIF contracts. The GAO sample has an even tighter distribution (standard deviation is 0.06) than our data (0.26) and it is left-skewed (skew is -0.3). The GAO sample and our sample are quite different; our data sample spans over 30 years while the GAO spans only about 5 years: 1976–81.

²¹ We were not able to collect enough complete CPFF and CPAF contracts from the CCDR database.

²² The skew of the CPIF sample is 2.8, whereas the skew for a normal distribution is 1.

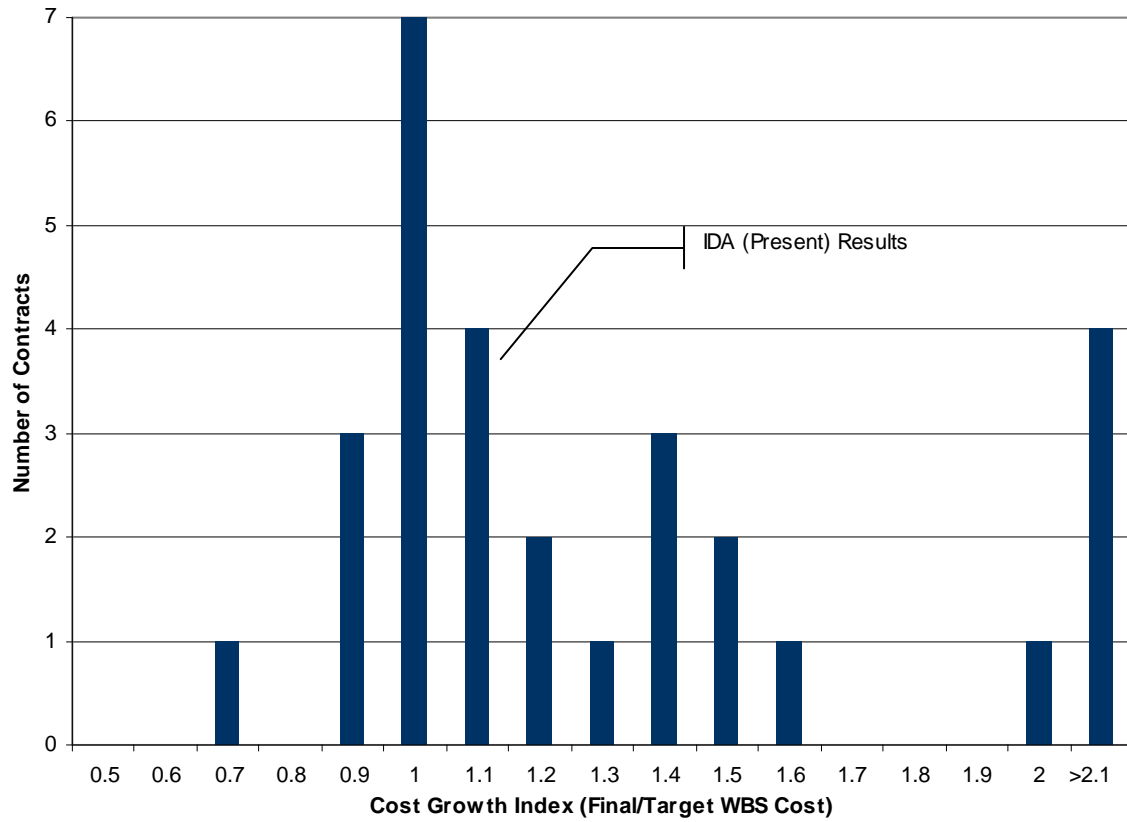


Figure 1. Distribution of the Cost Growth Index for a Sample of CPIF Contracts

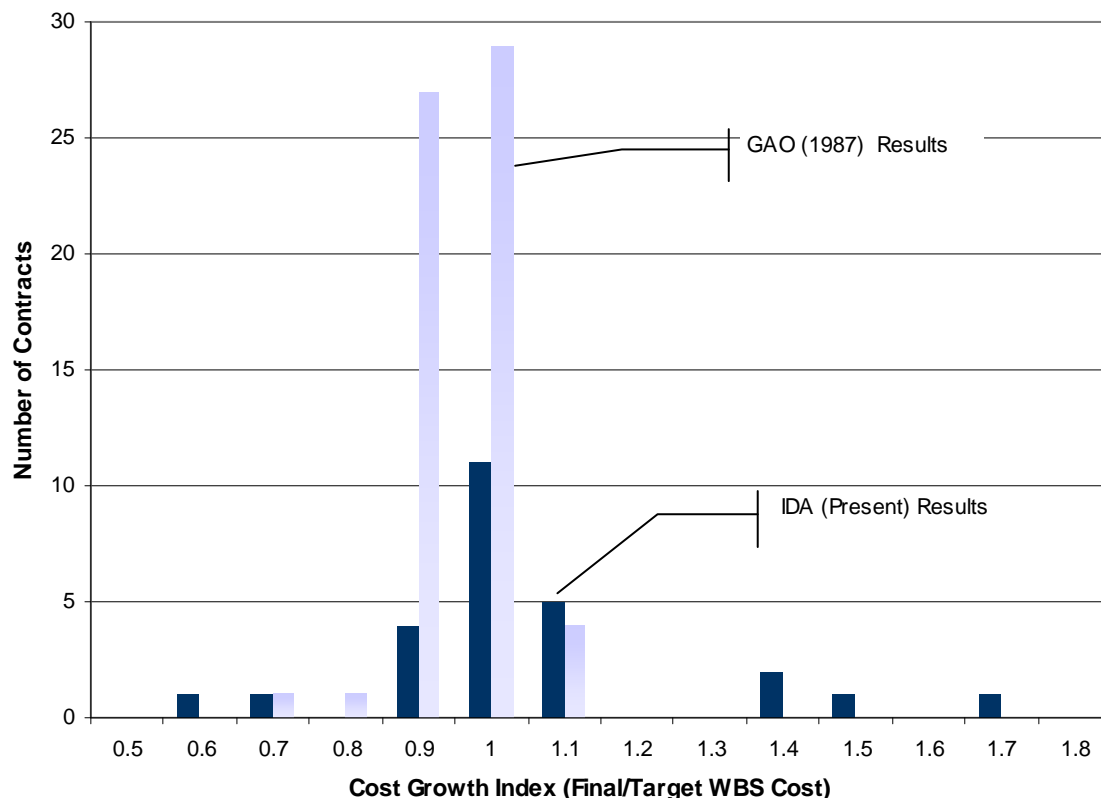


Figure 2. Distribution of the Cost Growth Index for the IDA and GAO Samples of FPIF Contracts

The decrease in both the cost growth index and its standard deviation are consistent with empirical observations from the earlier IDA, RAND, and GAO studies.²³ Another purpose for showing the distribution of the cost growth index in Figures 1 and 2, is to emphasize that, in spite of the evidence of the benefits of incentive contracts *on average*, the individual contract outcomes are highly variable. For example, while the data indicate an FPIF contract likely to finish close to the target, a CPIF contract is likely to finish with some cost growth. This does not mean the government should shift more risk to the contractor; rather it implies that it is best to align the contract type to the project risk. The cost growth reduction we and others have observed is due both to the incentive effect that drives execution efficiency as well as the FAR guidelines for transferring more contract risk to contractors only when targets have the appropriate level of accuracy.

²³ RAND also reported lower cost growth as more contract risk is transferred to the contractor.

D. WHAT CAN WE INFER FROM THE EMPIRICAL EVIDENCE?

The early empirical studies, as well as our recent analyses of EV and CCDR system data, agree that incentive contracts are associated with lower cost growth. However, none of the studies have been able to address whether incentive contracts lead to lower cost. This question would require deliberate experimentation by the contracting community.

There are two logical explanations for why incentive contracts have less cost growth while at the same time they may not reduce cost. The first explanation is that put forward independently by IDA, RAND, and to a lesser degree, by the GAO. They argue that the contractor will negotiate away as much uncertainty as possible, through higher targets, to effectively insure against overruns. This implies that as the risk of the contract increases, the target will increase proportionately to offset costs—the “risk-offset” effect. This also implies that incentive contracts may not result in lower costs overall.

Second, the lower cost growth of incentive contracts may be the result of contracting officers correctly matching project risk to contract type. The implication is that the contract type selection scheme effectively sorts projects according to their natural propensity to overrun costs—the “risk-sorting” effect.

In fact these three factors—incentive effects, higher targets, and risk sorting—could be simultaneously acting to reduce cost growth in incentive contracts. So far, studies have not been able to determine which factor is more important.

E. SUMMARY AND CONCLUSION

Incentive contracts are the one tool in the profit policy set that seek to link contractor rewards to contract outcomes. The main empirical studies we reviewed, as well as our own analysis of more recent data, agree that incentive contracts are associated with lower cost growth. The empirical analyses appear to yield two possible reasons (they could also be working together) for the lower cost growth: the risk offset and the risk sorting effects. The first, offered by the earlier analyses, is that contractors negotiate away their cost risk by bidding sufficiently high targets. The other explanation, offered by the present analysis, is that the contract type selection guidelines allow the government to sort projects by their inherent propensity to overrun costs.

Both the risk-offset and the risk-sorting explanations for lower cost growth imply that the government cannot necessarily expect incentive contracts to yield lower cost growth on any given project by using stronger incentives. For example, if the government

were to try and use an incentive contract on a project that should be CPFF, they should expect one of two outcomes: the contractor will bid the targets very high (the risk-offset effect); or they will accept a target that is too low and incur a cost overrun (counter to the risk-sorting effect). The former case may be acceptable but may be little better than using a CPFF contract. The latter case is unsustainable and is likely to result in the contractor seeking equitable readjustment or litigation.

Regardless of why incentive contracts are associated with lower cost growth, the government must weigh their benefits *and* costs as part of the selection process. On the one hand, less cost growth means costs are more predictable, which would provide benefits in terms of budget and program stability. On the other hand, if higher negotiated costs do in fact accompany incentive-type contracts, the overall effect may not be reduced costs. The risk-sorting effect implies the government should plan on conducting ongoing honest quantification of the uncertainty around the target estimates and strong persistent program management if is to use incentives. Incentive contracting is not a “fire and forget” management tool.

IV. INCENTIVE IMPLICATIONS OF A SOLE-SOURCE MULTIPLE-CONTRACT FRANCHISE

This chapter turns to the question of the incentive effects of the overall profit level allowed on the sequence of contracts that compose many defense programs. Both the conventional wisdom on the weapon system acquisition process and the economic literature on defense contracting point to one such incentive effect of major importance—the incentives that large profits in the production phase create for competing contractors during the development phase of a program.

Analysis of this question requires expansion of the context used in the preceding two chapters. Those chapters are concerned with the incentive effects of individual contracts, viewed in isolation. The issue is whether (and if so, how) the Defense Department could systematically improve contract outcomes by use of an incentive contract or manipulation of individual elements of the weighted guidelines. The outcomes of interest were system performance, schedule, and cost. In practice, attention often is directed instead to performance shortfalls, schedule slips, and cost growth.

The relevant context for examining the incentive effects of the overall profit level on DoD contracts is the sequence of contracts typically involved in the acquisition of a major weapon system. Figure 3 depicts the defense acquisition management framework. The large colored blocks represent the major acquisition phases, while the blue triangles positioned between certain blocks represent major government decisions (or milestones). Below the acquisition phases are the contracts that are typically associated with each phase.

At Milestone A, the Defense Department typically awards technology development contracts to two or more firms that have an ability to design, demonstrate, and produce the system concept. These contracts are usually CPFF due to the research and development nature of the work. During this phase, firms develop their system concepts and demonstrate the feasibility of pertinent technologies.

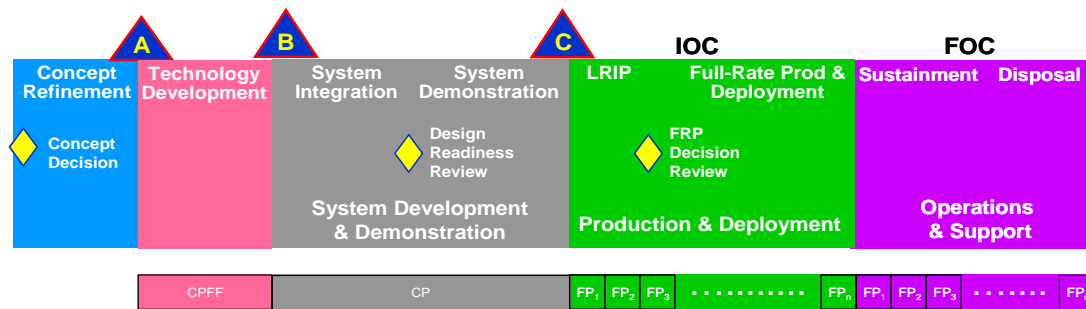


Figure 3. Defense Acquisition Management Framework

At Milestone B, the government typically selects one defense firm to develop a system, produce prototypes and systems that are tested, conduct demonstration testing, and prepare the system for production.²⁴ This effort occurs during the System Development and Demonstration (SDD) phase. Since this phase carries considerable risk, the contract is usually some type of cost-plus (CP) contract, either with incentives (CPIF, CPAF) or without incentives (CPFF).

After completion of SDD, the successful program enters production. Production typically is arranged through a sequence of annual lots, each for a specific number of the system, over a period of 10 to 15 years or more. The production phase ordinarily begins with a few years of low-rate initial production (LRIP). There is still some risk in the program at this point, so LRIP contracts typically have incentive features. Some combination of FPIF and FPAF would be characteristic. During full-rate production (post-Milestone C) an FFP contract is likely to be employed. Likewise, efforts associated with system deployment, sustainment, and disposal may involve discrete contracts or be included in the production contracts. Depending on the longevity of the system, follow-on contracts may be awarded for foreign sales, system upgrades, or system overhauls.

Rogerson provides a useful statement of a key problem the Defense Department faces in this context:²⁵

DoD...is unable to purchase the innovative efforts of firms directly. One problem is that a firm's level of innovative effort is difficult to monitor. DoD would find it difficult to observe and measure, for example, the level of management commitment to a project, whether the best engineers are working on the project, or

²⁴ There are notable exceptions to having only one firm receive a SDD contract. For example, during the System Development and Demonstration phase of the Joint Strike Fighter (JSF) program, two defense contractors were selected to develop the aircraft engine.

²⁵ See Rogerson (1994), p. 70.

whether the company has a relevant ongoing research effort. A second problem is that when delegating some decision-making authority to firms, DoD must provide the firms with incentives to make the decisions which are best from the DoD perspective, instead of, for example, using the firm's private information to choose projects likely to produce the most commercial spinoff.

Three features of the weapon system acquisition process that are tied up with profit policy combine to ameliorate if not solve this problem. The first, already noted, is competition between two or more firms at least in the pre-SDD phases of development. Second, the Defense Department seldom procures a system, once it is developed, from two sources.²⁶ In effect, at the end of the competitive phase, the Defense Department awards a production franchise to one of the competing firms. Third, it is commonplace for the bulk of the profits from defense contracting to come from production, not development. Rogerson has sharpened this point.²⁷ He found that individual large contracts provided returns above those normally available for comparably risky employments of capital. Note that these above-normal returns are not a violation of profit and contract financing policy, but a result of it. Indications are that the profits associated with these "downstream" contracts are significant. Rogerson (1992) estimated that returns to the defense industry exceeded their cost of capital by 3-5 percent.²⁸ Most of these profits are realized during production under the fixed-price-contract structure that allows firms to incur both profits and risk.

Defense producers gain above-normal returns by winning competitions for contracts, and they win competitions by developing the system that the Defense Department judges to be the best. In that way, the lure of supranormal profit during the production phase incentivizes the behavior during research, development, test, and evaluation that the Defense Department seeks. Moreover, defense firms have an incentive to recycle profits above the normal level into development work that increases their chances of gaining future contracts. (As Rogerson notes, this implies that the profits obtained by the firm on its defense work as a whole may not be supranormal even though the returns on individual production contracts are.)

²⁶ Procurement from two sources—that is, dual sourcing—was used for a number of major systems during the 1970s and 1980s when production runs tended to be longer. Since then, dual sourcing has become much less common but is still used occasionally.

²⁷ See Rogerson (1994) pp. 73-4, which discusses his findings and provides references to them.

²⁸ Rogerson (1992) estimated that economic rents to the defense firm are between 3.26 percent and 4.68 percent. His study was based on changes in the firm's stock price when prime contracts were awarded for military aviation acquisition projects.

The cross-contract incentives presumably are strongest for systems like aircraft, which tend to have active competition during the pre-SDD phase and remain in full-scale production for years. The incentive probably is weakest for systems like satellites for which there may effectively be no production phase. The incentive also clearly is weaker to the extent that the size of procurement programs, relative to the development that precedes them, decreases. However, these developments, as well as the potentially offsetting benefits of more complex service and operations and maintenance contracts, has not been studied in this context.

Rogerson described cross-contract incentives in terms of “prizes for innovation.” This is a reasonable characterization, because it was ordinarily technological innovations that permitted improvements in system performance that attracted the “prize” of supranormal returns. Prizes for innovation and recycling of above-normal profit into additional development work were particularly appropriate during the cold war, because a race for technological superiority was an important part of that war. Whether cross-contract incentives can do as well in encouraging other considerations—reliability, for example—is not obvious.

We are not aware of any systematic exploration of alternatives to prizes for innovation for harnessing contractor’s interests to the Defense Department’s during the competitive portion of systems developments. We did not attempt such an exploration as part of this study.

It is appropriate, before leaving implicit cross-contract incentives, to note how they relate to the explicit contract incentives identified in the previous two sections. First, the existence of above-normal returns during the production phase can be expected to reduce the effectiveness of explicit incentives incorporated in contracts during the development and early production phases. For example, assume that, in addition to a standard cost incentive, the development contract also uses as a cost metric the unit production cost that will become the price in the first production lot. In particular, assume that contract provisions pay the firm for reducing unit production costs during SDD and LRIP below historical norms. But lower unit *production* cost early in the program will often mean lower profit later, and that prospect of lower future profit easily could swamp the explicit incentive features of the development contract. From the viewpoint of the firm, the implicit incentives in a multi-contract acquisition program are powerful and may justify short-term losses for future gains. Performance is the most important parameter in determining the likelihood of earning a follow-on contract. As a result, defense firms may sacrifice cost and schedule (within some level of government tolerance) to boost the

performance parameter. Put positively, an effective explicit incentive in a development or early production contract must be large enough to induce the firm to forego some future profit, and that might well require incentive payments much larger than those available in conventional incentive contracts.

Second, there is a tradeoff between explicit contract incentives directed towards better contract outcomes in terms of performance, schedule, and cost on the one hand, and incentives provided by the attraction of supra-normal production phase profits on the other. The former incentives are intended to reduce, and in the end eliminate the high profits that constitute the latter incentive. A vigorous and effective use of explicit incentive features during development and early production would, then, run the risk of greatly damaging the powerful goal-aligning implicit cross-contract incentive feature of profit policy.

V. CONCLUSION

The goal of this study was to understand the contract incentive features provided within the framework of the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS)—what they are, how they work, how effective they are. Toward that end, we examined:

- Provisions in the DFARS (commonly referred to as the “weighted guidelines”) on the determination of the base fee specified in a typical DoD acquisition contract.
- Guidelines in the FAR on choice of contract type, in particular, contracts with incentive features.

We also considered the incentive effects that operate across the sequence of contracts, from development through full-rate production, through which acquisition programs typically proceed.

The specific conclusions we reached are as follows:

1. The facilities markup was used successfully in the mid-1970s to increase the capital/labor ratios of defense contractors. Such use of facilities markup would influence cost, not cost growth. The effect on cost depends on the capital/labor ratio. If the amount of capital employed already is at the optimal level, further increases (induced by increases in the facilities markup) will increase, not reduce, cost. Accordingly, facilities markup is not a tool that is easy to use.
2. The elements of weighted guidelines can usefully be thought of as being like prices; but by increasing certain prices the government can induce firms to propose more technically challenging approaches, put greater effort into management of contract outcomes, and be more willing to undertake the risks associated with a fixed-price contract. We do not know the magnitude of these effects, however, and they may be masked by other factors. Consequently, this linkage cannot be systematically exploited to promote better contract outcomes.
3. This study, like several past studies, finds that contracts with incentive fee or award fee provisions generally have less cost growth than contracts without such provisions. This finding does not imply, however, that greater use of these contracts by the Defense Department would produce better contract outcomes. This is true for several reasons. The most important is that the Defense Department cannot simply force contractors to take on the greater risk of a

contract with incentive features. Contracts are negotiated, and the degree of risk is not just a matter of provisions on fee; target cost also matters, and a contractor presumably would seek to offset the risk introduced by negotiating a higher target cost. The net result could be a contract that experiences less cost growth but with a cost to the Defense Department that is the same or even greater. It is also important to realize that the observed reduction in cost growth may be inextricably linked to the selection bias created by matching lower risk projects to contracts that transfer successively more risk to the contractor.

4. The comparatively large profits during the production phase of an acquisition have an important incentive effect. A defense firm ordinarily must first win a development contract to be chosen eventually to produce the system. Firms win competitions by developing the system that the Defense Department judges to be the best. In that way, the lure of profit during the production phase incentivizes the behavior during development and low-rate initial production that the Department seeks.
5. There is a tension between the goals of the incentive provisions of development and low-rate production contracts and the cross-contract incentives of comparatively large profits of the production phase. On the one hand, the prospect of large profits during the production phase can be expected to reduce the effectiveness of incentives in development and early production contracts intended to lower procurement cost, and therefore lower profit during production. On the other hand, a vigorous and effective use of incentive features of profit policy during development and early production would, then, run the risk of greatly attenuating the cross-contract incentive feature of profit policy.

Taken as a whole, these conclusions tend to suggest that there is not a realistic prospect of using the incentive tools permitted by DFARS to greatly improve the average performance, schedule, and cost outcomes the Defense Department obtains.

APPENDIX:

DO DOD CONTRACTS PROVIDE SUFFICIENT RETURNS?

To answer this question, we compared profits in the defense industry to other sectors. This analysis allowed us to infer whether DoD contracts are sufficiently profitable to maintain adequate capital.¹

CHOOSING APPROPRIATE STATISTIC FOR INTER-SECTOR COMPARISONS

It is necessary to select a metric that is appropriate for an inter-sector comparison of profitability. This metric should not only measure profitability, but also normalize any industry-specific peculiarities.

Some past analyses have used earnings generated by revenue (also called operating margin) as a metric of firm profitability.² On the surface, an inter-sector comparison of operating margins appears to provide a convincing argument that defense contractors require additional compensation. Figure A-1 shows the operating margin for the defense industry firms (in the S&P 500), several capital-intensive peer industries, and broader industry segments for the period 1989–2006. Aside from 1993 and the sharp technology downturn after 2000, the defense industry has the lowest profit margins of the group. Studies by Weidenbaum (1968) and the Comptroller General (1971) present similar trends between defense contractors and other industries.³ While operating margins provide valuable information, these ratios are often a poor metric for inter-sector comparisons. Operating margins measure only a portion of firm profitability. Also critical are such factors as risk management and the cost of capital. These latter two factors are especially relevant to the defense industry.

¹ Note that the effects of profit policy on contractor profits can only be inferred. Profits and capital are influenced by numerous market factors, government profit policy being just one.

² Mathematically, operation margin is calculated by dividing earnings before interest and taxes (EBIT) by revenue.

³ See Weidenbaum (1968) and Comptroller General of the United States.

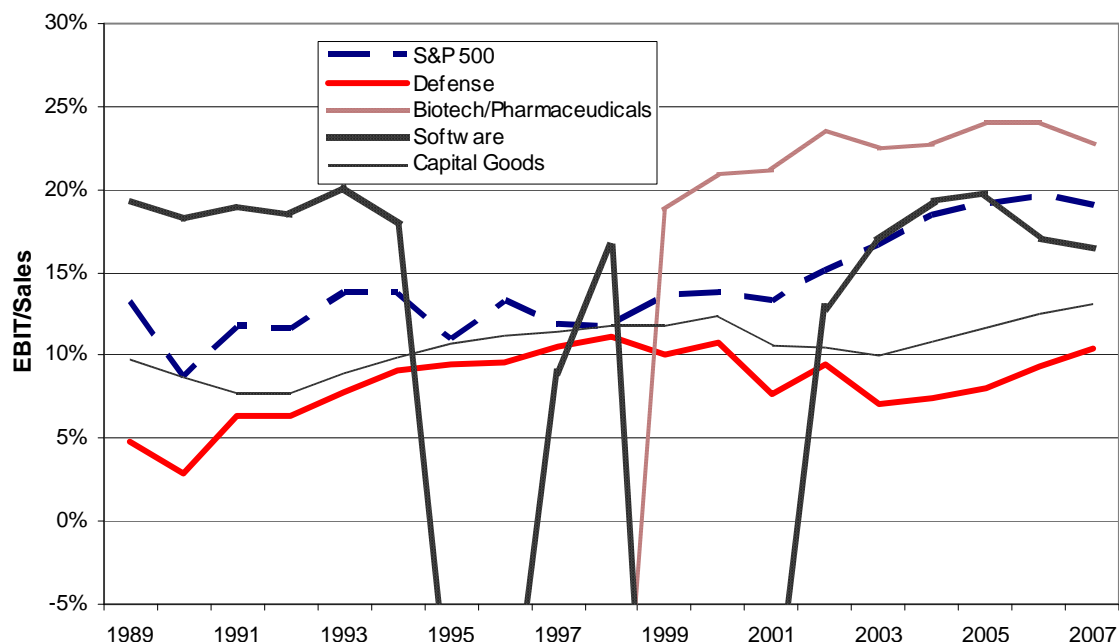


Figure A-1. Historical Operating Margins for the Defense Industry, Several Capital-Intensive Peers, and the S&P 500

The products and services provided by the defense industry are complex, somewhat akin to high technology firms and capital goods manufacturers. Firms that produce comparable products to defense companies include capital goods manufacturers such as Caterpillar; automotive manufacturers such as Ford; information technology suppliers such as IBM; and pharmaceutical companies such as Merck. There is, however, an important distinction. Defense companies differ from these commercial peers in that their customer base (mostly the U.S. Government) directly funds product development expenses, capital for unique tooling, and up to 90 percent of working capital costs. Figure A-2 illustrates these important differences by comparing the expenses of a commercial firm (Ford) and a military prime contractor (Lockheed).

Who Pays for the Major Elements of the Product Cycle Expense						
Product	Pre Program/SDD	Facilities & Buildings	Tooling	R&D/SDD	Working Capital	Unit Profit
JSF	Government	Lockheed/ Government	Government	Government	Lockheed/ Government	Government
Escape	Ford	Ford	Ford	Ford	Ford	Customer
R&D		Capital Expense		R&D	Financing	Profit Margin

Figure A-2. Cost Comparison: Major Product Cycle Expenses

The government provides a number of contract financing tools for augmenting contractor working capital. Although there are several variations, progress payments can be based on costs incurred and paid monthly. Progress payments are limited to 80 percent for large, 90 percent for small, and 95 percent for small disadvantaged contractors. Performance-based payments provide up to 90 percent of pre-determined costs once the contractor reaches a pre-determined milestone. Notice that the latter type of contract finance has some incentive effect towards achieving the predetermined schedule: the contractor does not get paid until milestones are reached. In principle, both types of payments should cover no more than the contractor's incurred costs.

The government can also make advance payments to prime contractors, for example, for subcontracted long lead elements. It is also able to provide loan guarantees so that a contractor can obtain lower financing from a private banking institution. In general, the FAR has a stated preference order for extending contract financing from the government: private financing; performance-based payments; progress payments; loan guarantees; and advanced payments.

Given the unique treatment of these financial items, a measure of profitability should be selected that is not biased by government contracting peculiarities. It should also take into account the risk to the investor. This risk is not a purely theoretical concept. Investors in a firm will demand greater returns for higher levels of risk. These investors could be either stockholders or debtholders. Depending on the type of investor, compensation can be in the form of stock value, dividends, or interest payments.

COMPARISON OF DEFENSE INDUSTRY RETURN

A fairly precise measure of profitability can be found in a firm's free cash flow return on invested capital (FCFROIC). In layman's terms, FCFROIC is a measure of the return to the firm after taxes and capital expenditures (CAPEX) have been paid. In essence, this statistic represents the residual profit available to stockholders and bondholders after investments necessary to maintain the firm as a going concern. Since the size of this residual profit will naturally be greater for larger firms, FCFROIC is normalized by dividing profit by the firm's total debt and equity. Another way to

interpret FCFROIC is that it represents the return generated by investments in debt and equity.⁴

FCFROIC is particularly suited for inter-sector comparisons involving the defense industry. FCFROIC's strict view of profits removes capital expenditures (e.g., facilities, buildings, tooling, and working capital). These adjustments are helpful for inter-industry comparisons because the defense industry is partially reimbursed by the government for these costs (see Figure A-2). Removing these expenses lessens the impact of these defense-specific contracting peculiarities.

Figure A-3 shows the FCFROIC for the defense industry and the same sectors shown in Figure A-1. In this case, the defense industry consists of prime contractors that derive their revenue primarily from U.S. government contracts.⁵ The results are much different than the operating margin comparison of Figure A-1. Since the post-cold war recession in the early 1990s, the defense industry has been among the FCFROIC group leaders. Even during the turn-of-the-century dot-com boom and bust, the defense sector had strong returns. One explanation of how defense firms generate high returns with low operating margins is that firm capital requirements are funded by the government during long and asset-intensive product cycles. This government funding provides comparatively large returns on investment from relatively low operating margins. Independent analyses by Weidenbaum (1968), Burns (1972) and Comptroller General (1971) also note this fact.

This relative comparison of FCFROIC in Figure A-3 does not tell us if investors are earning sufficient returns. This question requires that FCFROIC be compared to a metric that estimates the returns required by investors. The weighted average cost of capital (WACC) is the standard financial statistic that weights the returns demanded by investors that hold equity and investors that hold debt.⁶ Like FCFROIC, WACC is expressed as a percentage. Consequently, it is possible to compare these two metrics. If FCFROIC is

⁴ Mathematically, $FCFROIC_t = \text{Free Cash Flow} / \text{Capital}_{t-1}$; where Free Cash Flow = $\text{EBIT} \times (1 - \text{Tax Rate}) - \text{Net CAPEX} - \Delta \text{working capital}$; and $\text{Capital}_{t-1} = \text{Debt} + \text{Equity}$ at the end of the previous year.

⁵ These defense prime contractors include Lockheed, Raytheon, Northrop Grumman, and General Dynamics.

⁶ Mathematically, $WACC = \text{Debt} / (\text{Debt} + \text{Equity}) \times \text{Debt Cost} \times (1 - \text{Tax Rate}) + \text{Equity} / (\text{Debt} + \text{Equity}) \times \text{Equity Cost}$, where Equity Cost = 1yr T-Bill Rate + Beta \times Risk Premium. It should be noted that this study measures WACC retrospectively by looking at annually reported data. WACC can also be measured prospectively by using factors that predict a firm's future cost of capital.

greater than WACC, then returns are more than enough to compensate those who provide the firm's capital, given the risk of the firm's business environment.

Figure A-4 compares FCFROIC and WACC for defense prime contractors over the period 1989–2006. Since 1996, FCFROIC has been greater than WACC, implying that defense prime contractors have generally been creating shareholder value. In other words, firm profits are sufficient to compensate shareholders for their risk.⁷ It is important to note that this analysis indicates only that prime defense contractors are earning sufficient profits to satisfy investors and maintain adequate capital. It falls short of a conclusive answer to the important question of whether the defense industry is earning excessive profits.

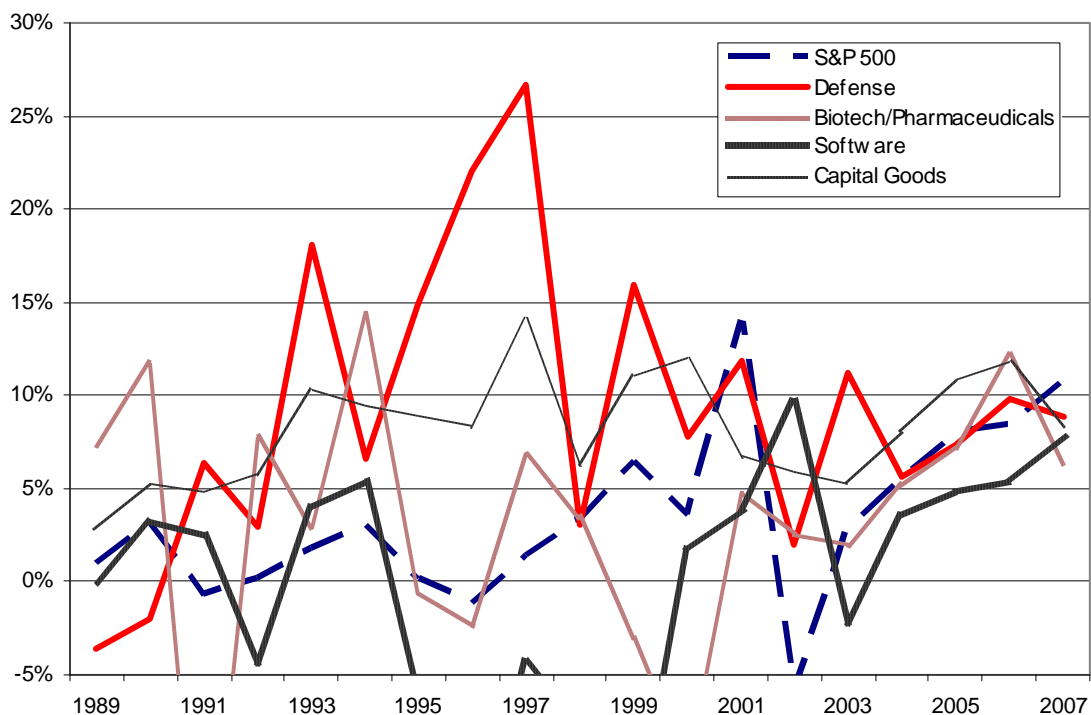


Figure A-3. Historical FCFROIC for the Defense Industry, Several Capital-Intensive Peers, and the S&P 500

⁷ Studies by Weidenbaum (1968) and Comptroller General (1971) argue that U.S. defense industries have been profitable for longer periods of time.

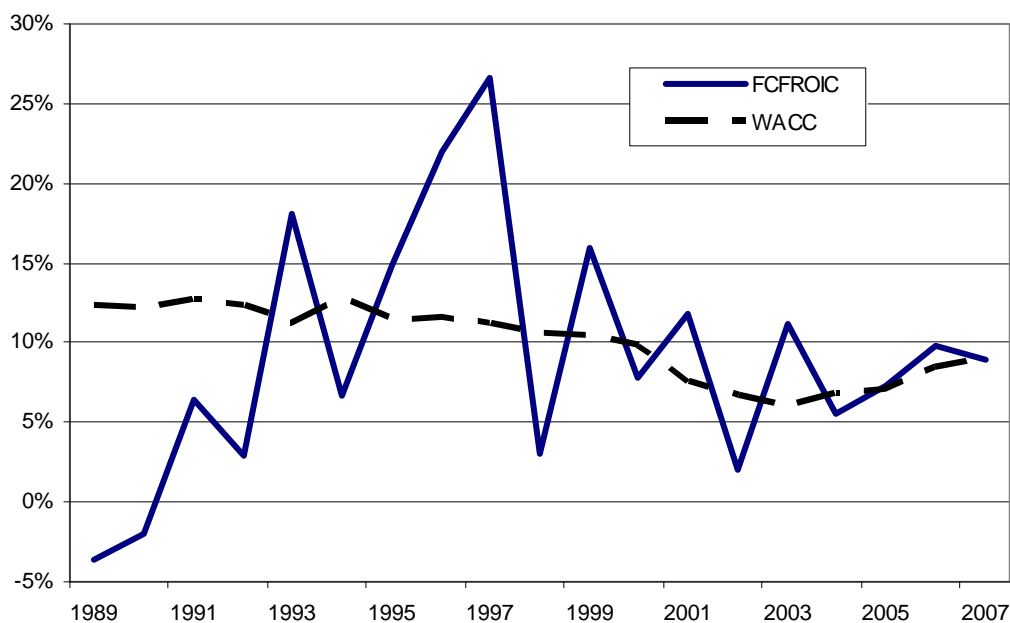


Figure A-4. Historical FCFROIC and WACC for the Top Prime Defense Contractors

This FCFROIC-WACC comparison is for prime defense contractors that derive their revenue primarily from U.S. government contracts.⁸ Consequently, the revenues of these firms are highly dependent on progress payments. Each year's revenue (1989–2006) can be thought of as a bundle of contracts that generate progress payments. The progress payments for any given year represent many disparate systems in various phases of the acquisition cycle. One can conclude from Figure A-4 that (since 1996) these payments have been sufficient to maintain both firm profitability and adequate capital.

⁸ These contracts may be across many government sectors.

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ABBREVIATIONS

CAPEX	capital expenditures
CP	cost plus
CCDR	Contractor Cost Data Reporting
CPAF	cost plus award fee
CPFF	cost plus fixed fee
CPI	cost performance index
CPIF	cost plus incentive fee
DAMIR	Defense Acquisition Management Information Retrieval
DFARS	Defense Federal Acquisition Regulation Supplement
DoD	Department of Defense
EBIT	earnings before interest and taxes
EV	earned value
FAR	Federal Acquisition Regulation
FCFROIC	free cash flow return on invested capital
FFP	firm-fixed price
FPIF	fixed-price incentive (firm target)
GAO	Government Accountability Office (formerly General Accounting Office)
IBM	International Business Machines
IDA	Institute for Defense Analyses
K	capital
L	labor
LRIP	low-rate initial production
R&D	research and development
ROIC	return on invested capital
SDD	System Development and Demonstration
S&P	Standard & Poor's
T-Bill	Treasury bill

TRL	Technology Readiness Level
WACC	weighted average cost of capital

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